

# Biofuels / Biomass

## Definition of Biofuels

Biofuels are liquid fuels such as alcohol derived from processing certain parts of various plants.

Biomass is any living or non-living animal and plant matter. There is much more plant mass than animal on Earth. Since plants absorb and store energy from the sun, converting biomass into biofuels means the biofuels can serve as an energy source.



## How are biofuels obtained?

Modern liquid biofuels need to be produced from original biomass. Animal-based or vegetable oils can be combined with other substances to generate a chemical reaction that yields biodiesel, a type of biofuel. Also, starch from crops like corn or sugarcane can be fermented into ethanol (alcohol), another type of biofuel. Finally, new developments are underway to try and find other means to obtain ethanol via non-food plant matter called cellulose and even non-food plants such as algae.

## What are biofuels used for?

Biofuels are used for transportation. In some instances, biofuel can completely replace regular gasoline. In other instances, biofuel is combined with regular gasoline. In fact, U.S. federal law dictates that the country's fuel supply is blended with a certain volume of biofuel. Due to this law, many gas stations now pump gas that is 10% ethanol.

## Brief History of Biofuels

Since man discovered how to make and control fire, we have been using biofuels.

### Wood



The most primitive biofuel is wood. In the distant past, early man burned wood for light, heat, cooking, and protection from animals. With the development of technology, wood was used to boil water for steam engines that powered machinery and locomotives. More recently, wood has been used as a fuel source for heating homes and for cooking purposes. In developing countries, wood is still used today for heating and cooking.

### Whale Oil



ONE OF THE WHALE'S MANY USES.  
Liquid spermaceti being drained from the head of a sperm-whale.

Whale oil was used for centuries and became very valuable for lighting with oil lamps in the 18th and 19th centuries. However, the rate at which it was used rendered it non-renewable. Many species of whales were brought to the brink of extinction due to whaling ships that did not account for preservation of the whale population in the world's oceans.

### Focus on Plants



Biofuels have historically come from both plants and animals, but animals are no longer harmed for fuel stocks. Whaling is now generally illegal internationally, although some poaching continues, sometimes under the guise of research. Emphasis has moved to plants for efficiency, biodiversity, and humanitarian reasons.

### DID YOU KNOW?

Animal feces, also known as dung, are still used in many parts of the world as an energy source.

## Biofuels Today

More recently, biofuels are being produced from cooking oils and derived from plants as ethanol, a type of alcohol. New developments are also occurring to expand the possibility of making ethanol from algae, as well as cellulose, the fibers that provide structure to plants.



**COOKING OILS:** Used vegetable oil or animal-based oil can be repurposed into a biofuel called biodiesel. Biodiesel is produced through a chemical reaction of the used oil with an alcohol, or with some engine modifications, used cooking oil can be filtered and used directly.



**CELLULOSE:** A new biofuel development is the possibility of making ethanol from wood, grasses, and other parts of plants by breaking down the cellulose that provides the structure of the plants.



**PLANTS:** Certain plants contain starches and sugars which can be fermented into ethanol. In the USA, because of overproduction of corn, most ethanol production comes from the starch in corn kernels. In Brazil, ethanol is more efficiently derived from sugar cane.



**ALGAE:** Another new development is the possibility of making ethanol from algae. Algae transform carbon dioxide into lipids, or oils, which can be extracted and refined into biofuel.

## Biodiesel: A Closer Look

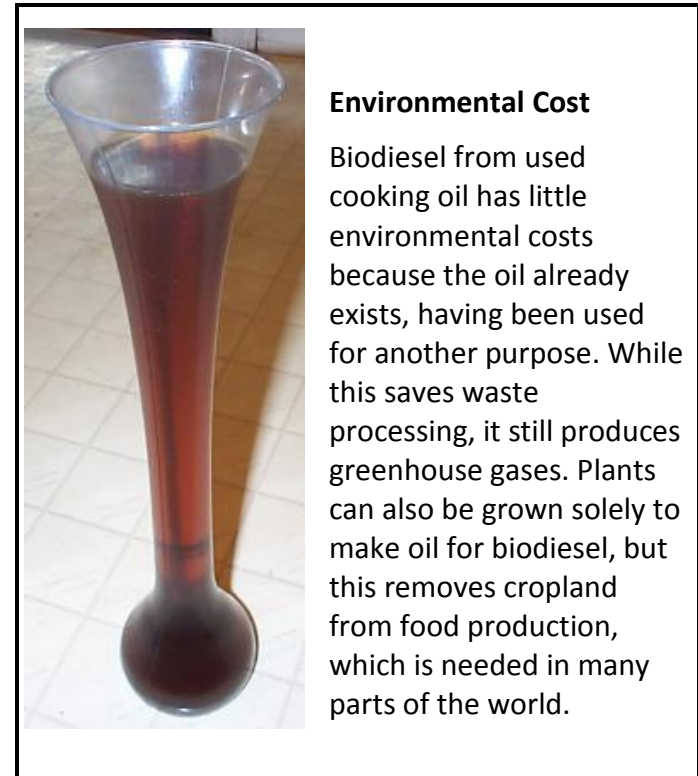
Large amounts of vegetable and animal-derived oils are used in cooking. Fast food restaurants and snack food factories create a lot of oil waste annually. The used oil can be refined for use in diesel engines in trucks, cars, and other vehicles.



To create biodiesel, the used oil must be filtered and all impurities must be removed. This can be done through a fairly easy chemical procedure. A growing number of private and commercial filtration systems are emerging.



Today in the USA, you can see biodiesel vehicles on the road. They look just like other vehicles, but have diesel engines. (Their exhaust smells a bit like French Fries, too.)



### Environmental Cost

Biodiesel from used cooking oil has little environmental costs because the oil already exists, having been used for another purpose. While this saves waste processing, it still produces greenhouse gases. Plants can also be grown solely to make oil for biodiesel, but this removes cropland from food production, which is needed in many parts of the world.

### DID YOU KNOW?

As energy efficiency grows in importance, additional waste products of modern society are being burned for energy. These can include burning old tires or non-recyclable plastics in cement kilns, co-generation of heat and electricity, and many others.



## Ethanol: A Closer Look

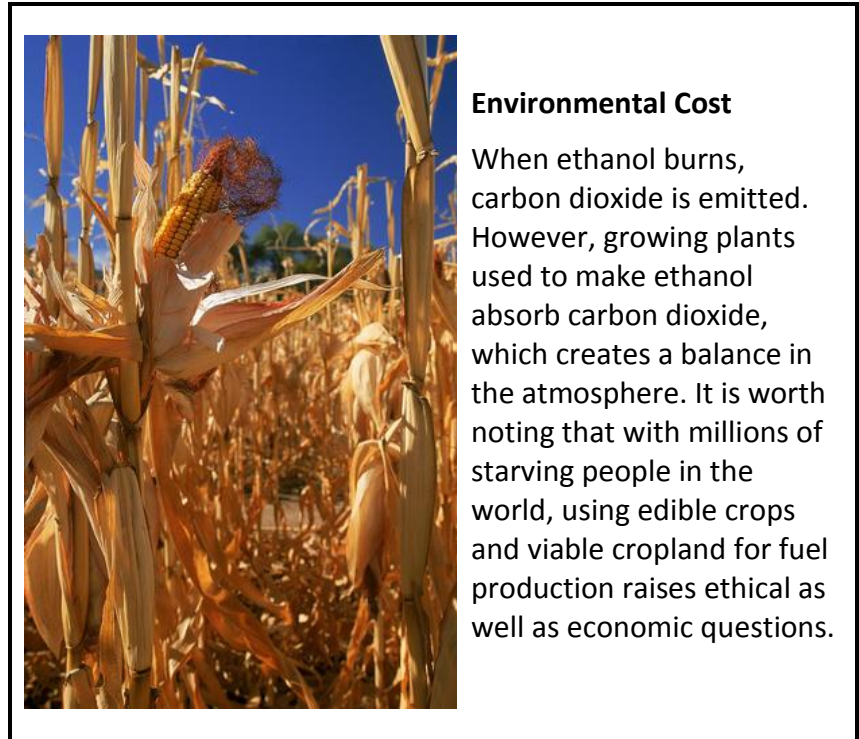
Ethanol is a type of alcohol which burns and can be used in various types of gasoline engines. As compared to the same weight of gasoline, ethanol stores somewhat less energy.



Ethanol can be made by chemically breaking down sugars found in many plants, such as corn or sugar cane. Basically, ethanol is produced through a fermentation process similar to brewing beer.



Ethanol can be mixed with gasoline or used as a replacement for gasoline. In the U.S., almost all gasoline sold has a percentage of ethanol in it. In fact, most existing car engines can run with ethanol-gasoline blends up to 10-15% ethanol.



### Environmental Cost

When ethanol burns, carbon dioxide is emitted. However, growing plants used to make ethanol absorb carbon dioxide, which creates a balance in the atmosphere. It is worth noting that with millions of starving people in the world, using edible crops and viable cropland for fuel production raises ethical as well as economic questions.

## Ethanol from Cellulose

The limited availability of biomaterials for ethanol production has spurred interest in converting cellulose into ethanol.



Cellulose is the material found in virtually all plants, and makes up the woody substance, the stiffness in grasses, and provides structure to plants in general. People cannot digest cellulose, so it is not food.



Cellulose is made up of long chains of sugar molecules. There are some processes available to separate those sugars so that the sugars can then be converted to ethanol.



### Environmental Cost

The problem is that conversion processes are both energy-intensive and expensive. Scientists are conducting research to find more efficient ways of breaking down cellulose to produce fuel from rapidly growing plants such as switchgrass.

### DID YOU KNOW?

Some crops can serve a dual purpose in biofuel production. Certain plants can be squeezed to provide oil for biodiesel and then the fibers that remain can be used for cellulosic ethanol.

## Ethanol from Algae

New biotechnologies are being researched in order to find ways to use the rapid growth of algae to produce ethanol directly.



Algae can produce more oil than similar areas devoted to more typical plants such as corn or rapeseed. It can also be grown on land that is unsuitable for most crops, because it can grow in deserts, saline environments, and other marginal lands.



In some cases, it is possible to grow algae in smoke stacks. The algae benefits from the excess carbon dioxide emitted from fossil fuel burning and the algae removes some of the carbon dioxide from the exhaust gases.



### Environmental Cost

The use of carbon dioxide for algal growth makes algae a fuel source with no carbon footprint. Growing algae removes carbon dioxide from the atmosphere. While, burning algae fuel emits carbon dioxide. The whole process is balanced and considered carbon neutral.



## Benefits and Challenges of Biofuels

### BENEFITS

Biofuels offer significant benefits, which include:

- Biofuels are considered a sustainable resource because they can regrow in the course of a person's lifetime, and thus contribute to sustainable energy production.
- Biofuels can be carbon neutral. This means that although burning biofuel emits carbon dioxide into the environment, it is balanced by creating biomass for biofuel which reduces carbon dioxide in the environment.
- Biofuels are non-toxic and biodegradable. They burn much cleaner than their fossil fuel counterparts.
- Biodiesel can make use of unwanted and already used oil. Cellulosic ethanol, once industrialized, will make use of the inedible woody fibers that usually end up as crop waste.



### CHALLENGES

There are challenges to using biofuels, which include:

- Biofuels are only renewable as long as they are used at a slower rate than they can regrow.
- Even with crops that are inedible by people, there is a question of converting fertile agricultural land—that could be used to feed billions of people—into land used for energy production.
- Establishing a farming area for biofuel crops often means cutting down mature trees which remove more carbon dioxide from the atmosphere than the plant crops. Tree removal can also lead to soil erosion and a change in the local biodiversity.
- Producing certain biofuels—like corn—requires lots of water: for irrigating crops and running the refineries.

**FINAL THOUGHT:** Each of the traditional and emerging methods of biofuel production have advantages and disadvantages, but they all have one aspect in common, and that is they all require land and good soil to grow. This is a social, economic, and political issue that will need to be resolved in the coming years.